SOUTH DAKOTA STATEWIDE FISHERIES SURVEY

2102-F21-R-46

Name: Stockade Lake **County:** Custer

Legal description: Sec 21, 22, 27, and 28; T3S, R5E
Location from nearest town: 3 miles east of Custer, SD
Dates of present survey: May 28-30, June 11, and Sept 8-9, 2013
Dates last surveyed: May 14-16, June 11, and Sept 10-11, 2012,
Most recent lake management plan: F-21-R-36 Date: 2004
Management classification: Coldwater marginal
Contour mapped: June 1986

Primary Species: (game and forage)	Secondary and other species:
1. Largemouth Bass	1. Bluegill
2. Smallmouth Bass	2. Black Bullhead
3. Yellow Perch	3. Golden Shiner
4. Black Crappie	4. White Sucker
5. Northern Pike	5.

PHYSICAL CHARACTERISTICS

Surface Area: 130 acres **Watershed:** 42,880 acres
Maximum depth: 13.7 m (45 feet) **Mean depth:** 4.8 m (15.8 feet)
Lake elevation at survey (from known benchmark): full

Ownership of lake and adjacent lakeshore property:

Stockade Lake is owned by the State of South Dakota and lies within the boundaries of Custer State Park.

Fishing Access

Stockade Lake receives a high amount of fishing pressure from area residents and nonresidents because of its location in Custer State Park. Angling access to Stockade Lake requires a State Park annual sticker or seven day fee. The lake lies adjacent to Hwy 16A and has easy access by way of roads on the northeast, north central and northwest side of the lake. A boat ramp lies on the east side of the lake. A fishing pier is present at the end of the road on the north central side of the lake.

Watershed Condition and Land Use

Primary use of the Stockade Lake watershed includes timber sales (60%) administered by the U.S. Forest Service (USFS), pastureland (20%), municipal water use (15%), and mining (5%). Livestock grazing occurs on private and USFS land surrounding the lake. Bismarck Lake has a surface area of 25 acres and drains into one of Stockade Lake's north bays. Custer Municipal Pond has an estimated surface area of four acres and is located on French Creek above Stockade Lake on Custer's west edge of town; however, it was drained in 2012 and does not currently hold water.

Observations of Water Quality and Aquatic Vegetation

Cattails were present along shorelines with shallow areas and also in bays. Submerged vegetation consisted mostly of pondweed in shallow areas. Summer algae blooms are generally heavy and have contributed to past summer kills.

Siltation and nutrient loading into Stockade Lake occurs from highway runoff, grazing, mining, and forestry practices via French Creek and Bismarck Lake Creek. The sewage treatment facility for the city of Custer was upgraded over the years, so city waste no longer enters the lake. From 1987 to 1990, silt removal from the French Creek inlet was accomplished by dredging and construction equipment (i.e. loaders and dump trucks).

Observations on conditions of structures (i.e. spillway, boat ramps and docks, roads, etc)

Stockade Lake has an aeration system, run by a 5-hp Quincy air pump. In 2011 the system received some maintenance to damaged hoses and other plumbing issues at the valve box. In early 2013 an airline near the island was resurfacing and was re-sunk later in the summer. This is a reoccurring problem, likely as a result of boaters catching anchors on the lines. Additionally, the generator shorts out during most thunderstorms and needs to be re-started. All other equipment and structures appeared in good condition.

MANAGEMENT OBJECTIVES

Objective 1. To maintain a trap-net CPUE value for stock-length Black Crappies greater than 10, maintain Black Crappie PSD greater than 20 and PSD-P greater than 5.

Objective 2. To maintain a gill-net CPUE value for stock-length Yellow Perch greater than 10, maintain PSD between 30 and 50, PSD-P greater than 5. Maintain predator densities at levels that, in addition to harvest, will effectively maintain Yellow Perch population values within objective ranges.

Objective 3. To maintain a Largemouth Bass fishery with a minimum night-time electrofishing CPUE for stock-length fish of 20, a PSD range between 20 and 40, PSD-P between 0 and 10.

CHEMICAL DATA

Water column parameter data was collected using a YSI Sonde monthly in May through September 2013. Stockade Lake does experience temperature and oxygen stratification (Figure 1). During the September 9th survey a thermocline was present starting around 3.5 m deep and dissolved oxygen levels dropped below an adequate level for fish around this depth also.

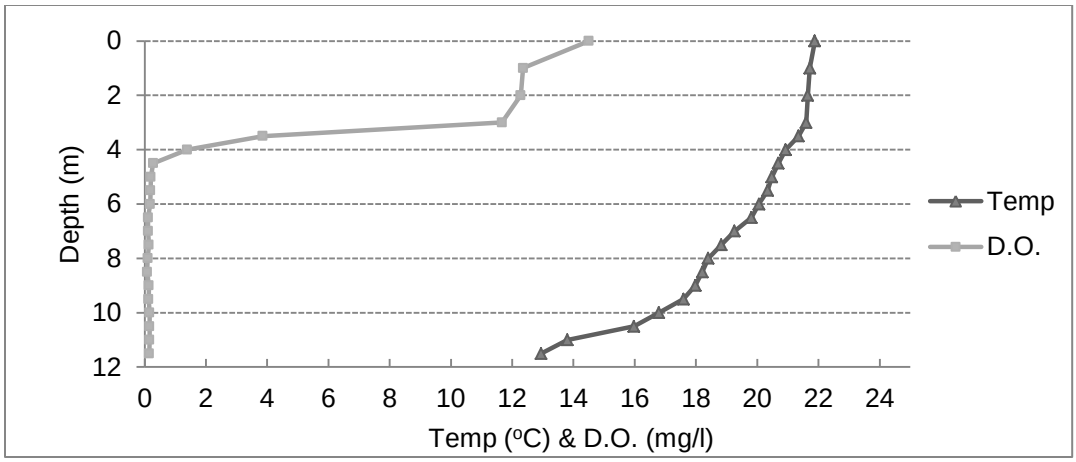

Figure 1. Temperature and dissolved oxygen (D.O.) profile with water depth taken with a YSI meter in Stockade Lake, South Dakota on 9/9/2013.

BIOLOGICAL DATA

Sampling Effort and Catch

A trap net survey consisting of eight net nights was completed on May 28-30, 2013 (Table 1, Figure 2). Trap nets were modified fyke nets consisting of a 1.3 X 1.5 m frame, 19.1 mm (0.75 in) mesh and a 1.2 X 23 m (3.9 X 75.5 ft) lead. Trap nets have been set in similar locations during previous surveys with six to eight nets set. Since 2011 trap net surveys have been conducted in May instead of July, as in previous years for improved panfish sampling. Prior to setting two gill nets on Sept 8, 2013 water column parameter data was collected using a YSI meter. Gill nets were then set at approximately 15-20 ft deep, as this was determined to be the depth where oxygen dropped below a habitable level. Gill nets were monofilament experimental type and measured 45.7 m (150 ft) long and 1.8 m (6 ft) deep with six 7.6 m (25 ft) panels of bar mesh sizes: 12.7 mm (0.5 in), 19.1 mm (0.75 in), 25.4 mm (1.0 in), 31.8 mm (1.25 in), 38.1 mm (1.5 in), and 50.8 mm (2.0 in). All nets remained in the water overnight for a total of six trap net and two gill net nights. Otoliths were collected from the first five fish of each centimeter group for Yellow Perch collected from gill nets. Otolith samples were examined under a dissecting scope and number of rings recorded as age.

Night electrofishing was conducted at Stockade Lake on June 11, 2013 to sample largemouth and Smallmouth Bass. This was conducted using a Smith-Root 18-hp electrofishing boat with pulsed-DC current at approximately 150 volts and 6-8 amps. Six ten-minute sites are usually completed for this survey; however, only three sites were completed due to a thunderstorm (Figure 2).

Seven different species of fish were caught during the survey (Table 2 and 3). Yellow Perch was the most abundant species in gill and trap nets making up 92% of the gill net catch and 88% of the trap net catch. Night boat electrofishing results for Largemouth and Smallmouth Bass are in Table 4.

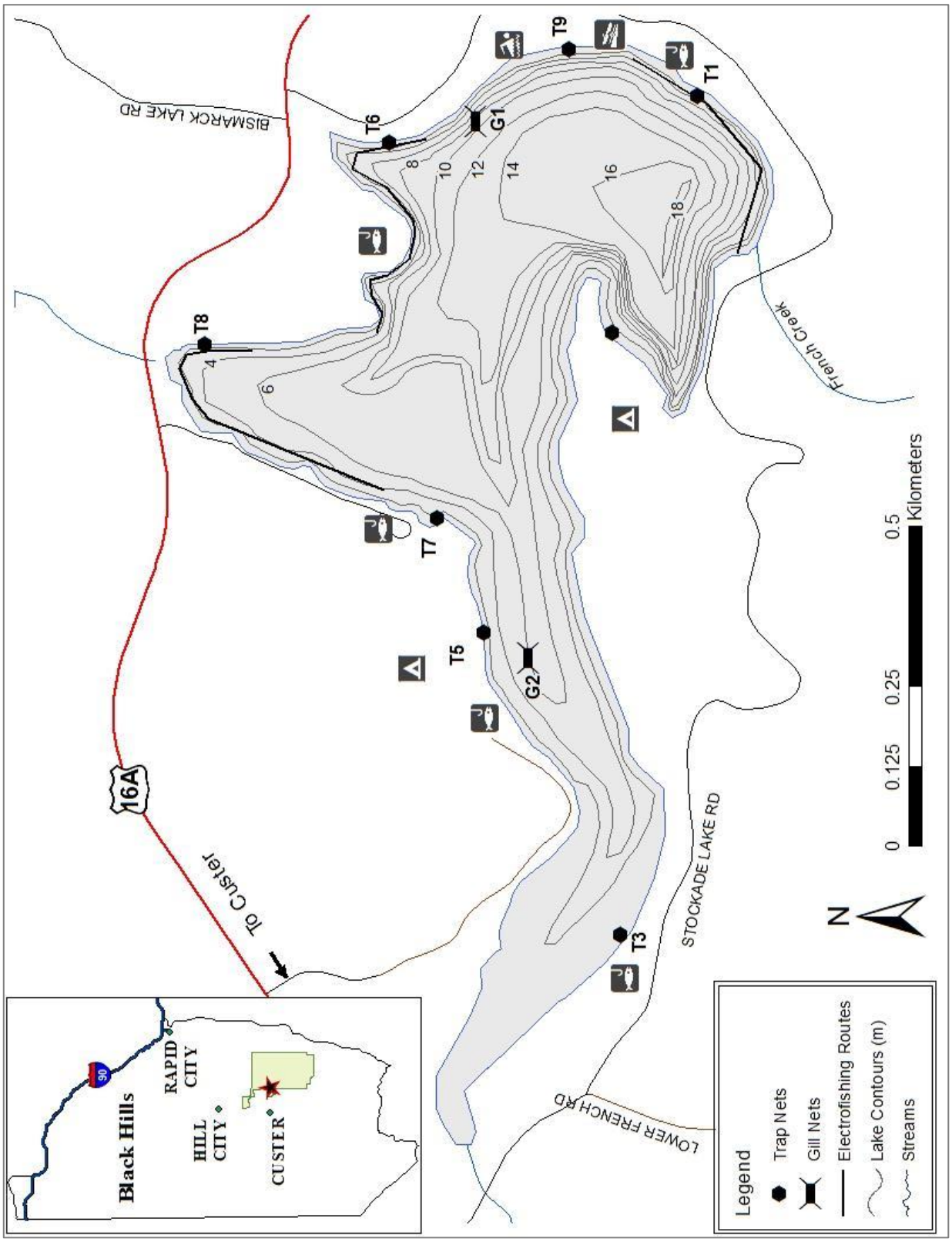

Figure 2. Lake map and 2013 sampling sites at Stockade Lake, Custer County, South Dakota.

Table 1. Net locations for 2013 fisheries survey of Stockade Lake, South Dakota.

Set Date	Net #	UTM Long	UTM Lat
5/28	Trap Net 1	619861	4846927
5/28	Trap Net 2	619490	4847060
5/29	Trap Net 3	618553	4847046
5/29	Trap Net 5*	619022	4847258
5/28	Trap Net 6	619788	4847406
5/28	Trap Net 7*	619213	4847338
5/29	Trap Net 8	619473	4847694
5/29	Trap Net 9	619934	4847130
8/31	Gill Net 1	619795	4847183
8/31	Gill Net 2	619862	4847123

*set in different location than previous years

Table 2. Total catch for two gill nets in Stockade Lake, South Dakota on September 8-9, 2013. Parameters are reported with confidence intervals in parentheses.

Species	N	CPUE (80%)	CPUE-S (80%)	PSD (90%)	PSD-P (90%)	*Wr*≥S (90%)
Black Bullhead	2	1.0 (3.1)	1.0 (3.1)	50 (50)	50 (50)	114.3 (11.4)
Black Crappie	22	11.0 (30.8)	8.5 (26.2)	23 (15)	6 (16)	108.4 (0.5)
Bluegill	13	6.5 (1.5)	6.5 (1.5)	100	62 (25)	112.3 (1.5)
Northern Pike	2	1.0 (3.1)	1.0 (3.1)	100	100	88.1 (0)
Yellow Perch	437	218.5 (399)	219 (399)	76 (4)	30 (3)	94.2 (0.7)

Table 3. Total catch of eight overnight trap net sets in Stockade Lake, South Dakota on May 28-30, 2013. Parameters are reported with confidence intervals in parentheses.

Species	N	CPUE (80%)	CPUE-S (80%)	PSD (90%)	PSD-P (90%)	*Wr*≥S (90%)
Black Bullhead	2	0.25 (0.23)	0.25 (0.23)	100	100	101.6 (55.5)
Black Crappie	5	0.63 (0.35)	0.38 (0.25)	40 (52)	67 (33)	103.7 (21.9)
Bluegill	37	4.6 (3.2)	4.6 (0.35)	86 (10)	19 (11)	120.7 (6.5)
Northern Pike	7	0.88 (0.56)	0.88 (0.56)	71 (29)	57 (39)	98.1 (4.3)
Yellow Perch	384	48.0 (28.6)	48.0 (28.6)	99 (1)	26 (4)	96.4 (1.1)

Table 4. Total catch of three sites of night electrofishing in Stockade Lake, South Dakota on June 11, 2013. Parameters are reported with confidence intervals in parentheses.

Species	N	CPUE (80%)	CPUE-S (80%)	PSD (90%)	PSD-P (90%)	*Wr*≥S (90%)
Largemouth Bass	23	46.0 (47.3)	36.0 (45.7)	72 (19)	22 (18)	111.1 (4.2)
Smallmouth Bass	2	4.0 (3.8)	4.0 (3.8)	100	50 (50)	64.4 (142.90)

Yellow Perch

A new regulation went into effect in Jan 2011 that reduced the daily limit for panfish (including Yellow Perch) from 25 per day to 15 per day. It is unlikely that this will affect the fishery in Stockade Lake, but annual monitoring should provide insight to any future changes or trends of the population.

Gill net catch rates for stock length Yellow Perch in 2013 increased for the third year in a row (Table 5). The size structure of Yellow Perch has increased slightly over the last couple years with more quality length fish (PSD=76) (200 mm or 8 in) and a large increase in preferred length fish (250 mm or 10 in) (PSD-P=30) in 2013 (Figure 3). Condition (*Wr*) is good with values still in the 90s. The management plan for Stockade Lake Yellow Perch is to maintain a gill-net CPUE value for stock-length fish greater than 10, maintain PSD between 30 and 50, PSD-P greater than 5, and growth at or near the regional average. Stockade Lake has met and exceeded these goals for the past three years.

Aging results indicate that this population reaches quality length (200 mm or 8 in) around age three (Table 6). This growth is similar to the South Dakota scale-aged mean and slightly faster than the Region 1 (Western SD) scale-aged mean (Willis, et al. 2001). However, ages collected by scales vs. otoliths should be cautiously compared. Otoliths will be taken from Yellow Perch in Stockade Lake for the next few years before conclusions can be made about growth in this fishery.

Also of note are yellow grubs found on the Yellow Perch. The grub occurs naturally in the area and appears to have a successful life cycle through birds, fish and snails at Stockade Lake. They are not harmful to humans either by eating infected fish or by contact with the water. Movement of water and fish from Stockade should be highly restricted to prevent transporting the grub to other lakes. Yellow grubs are also found in higher densities in fish at Bismarck and Lakota Lakes. Both lakes have illegally introduced Yellow Perch populations and are most likely a result of anglers transporting these fish and grubs from nearby Stockade Lake. Many anglers complain about the grubs and it is likely that this causes lower harvest rates than expected.

Table 5. Results for Yellow Perch captured during gill net surveys in Stockade Lake, 2004-2013. Parameters are reported with confidence intervals in parenthesis.

Species	N	CPUE (80%)	CPUE-S (80%)	PSD (90%)	PSD-P (90%)	*Wr*≥S (90%)
2004	113	37.7 (12.0)	37.7 (12.0)	63 (8)	2 (2)	94.8 (1.4)
2005	113	56.5 (47.7)	56.5 (47.7)	79 (7)	16 (6)	93.7 (0.5)
2006	100	50.0 (18.5)	34.5 (4.6)	48 (10)	23 (9)	90.7 (0.9)
2007	56	56.0 (--)	56.0 (--)	2 (3)	0	86.9 (0.6)
2008	86	43.0 (9.2)	32.5 (4.6)	5 (4)	0	86.3 (0.4)
2009	176	88.0 (49.2)	87.5 (50.8)	13 (5)	0	89.2 (1.1)
2010	44	22.0 (67.7)	22.0 (67.7)	48 (13)	0	97.5 (1.0)
2011	278	139.0 (95)	138.5 (93.9)	65 (4)	2 (1)	98.5 (0.8)
2012	351	175.5 (7.6)	160.0 (6.2)	74 (4)	9 (3)	99.5 (0.7)
2013	437	218.5 (399)	219.0 (399)	76 (4)	30 (3)	94.2 (0.7)

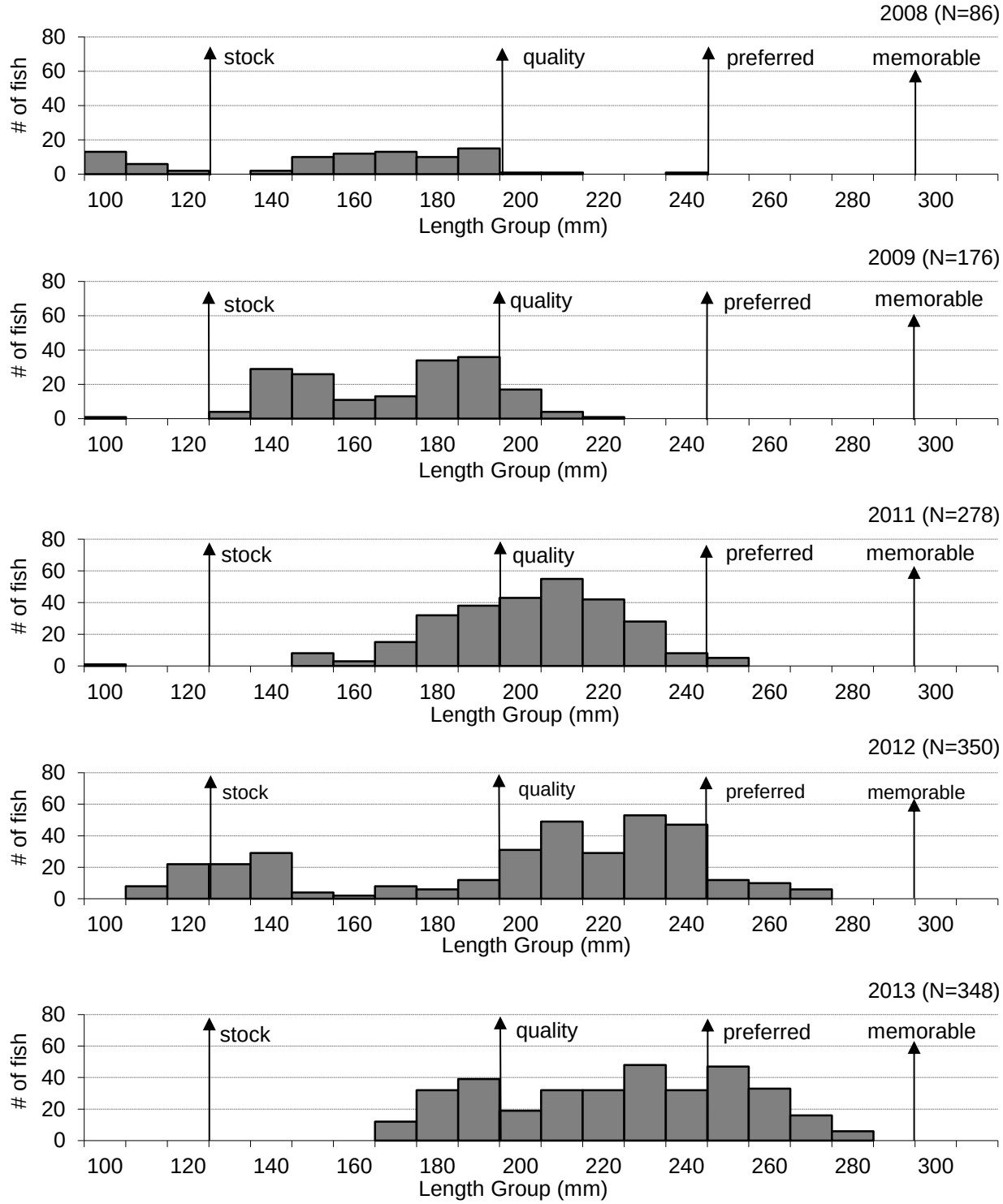

Figure 3. Length frequencies for Yellow Perch from gill nets at Stockade Lake, South Dakota in 2008-2013 (2010 in excluded due to low sample size).

Table 6. Stockade Lake Yellow Perch length range and weighted mean length (mm) at capture by otolith aged gill net sample during the 2013 lake survey, and Region 1 and South Dakota mean lengths by age (from scales) (Willis et al. 2001).

Age	Minimum	Weighted Mean	Maximum	# surveyed	Region 1 Scale-Aged Mean	S. Dak. Scale-Aged Mean
2	174	192	219	22	117	145
3	215	230	239	3	158	190
4	207	229	243	4	186	220
5	224	241	256	7	208	242
6	216	249	287	17	n/a	n/a
7	218	242	252	2	n/a	n/a
8	231	254	282	8	n/a	n/a
9	265	265	265	1	n/a	n/a

Largemouth Bass

A 15-inch (381 mm) minimum length limit for Largemouth Bass was established in 1995 in an attempt to improve Largemouth Bass and panfish population structures. The Largemouth Bass population is sampled annually in spring to monitor the bass populations and determine if the regulation is performing as intended. This year night electrofishing was accomplished on June 11, 2013.

Due to a reduced effort catch rates are not compared for 2013 (Table 7). Size structure appears high and well over management objectives with the 2013 sample having a PSD of 72 and PSD-P of 22. Fish condition is still excellent with an average *Wr* for stock length and larger fish at an all-time high of 115.

This is an impressive population and sampling data indicates that the 15 inch minimum is producing a quality Largemouth Bass fishery. The management goal for Largemouth Bass in Stockade Lake is to maintain a Largemouth Bass fishery with a minimum night-time electrofishing CPUE for stock-length fish of 20, a PSD range between 20 and 40, PSD-P between 0 and 10. It appears that abundance and size distribution have been exceeding these goals for several years.

Table 5. Results for Largemouth Bass collected during night-time electrofishing surveys of Stockade Lake, 2007-2013. Parameters are reported with confidence intervals in parentheses.

Year	N	CPUE (80%)	CPUE-S (80%)	PSD (90%)	PSD-P (90%)	*Wr*≥S (90%)
2007	214	214.0 (36.1)	210.0 (35.6)	52 (6)	12 (4)	113.0 (0.7)
2009	147	148.2 (49.2)	148.2 (49.2)	76 (6)	19 (6)	109.3 (0.5)
2010	72	72.7 (10.2)	67.7 (7.9)	73 (9)	24 (9)	97.4 (3.3)
2011	98	100.6 (37.6)	97.6 (38.9)	76 (8)	22 (7)	107.5 (0.3)
2012	213	213.0 (65.6)	171.0 (49.8)	76 (5)	12 (4)	114.7 (0.7)
2013	23	46.0 (47.3)	36.0 (45.7)	72 (19)	22 (18)	111.1 (4.2)

Smallmouth Bass

Smallmouth Bass were stocked into Stockade Lake in 1990, 1992, and 1993. They were added to the 15" minimum length limit in 2004. Smallmouth Bass catch rates (CPUE) have been low except for in 2007 and 2012. The 2013 survey only sampled two individuals, but only three passes were completed. The 2012 survey yielded a higher CPUE than normal with 28 captured (Table 8). Size structure was very good with PSD and PSD-P values of 70 and 30, respectively. Fish condition remained high with an average *Wr* value for stock length and longer fish of 97.

Table 8. Results for Smallmouth Bass captured in Stockade Lake during night electrofishing surveys, 2007-2012. Parameters are reported with confidence intervals.

Species	N	CPUE (80%)	CPUE-S (80%)	PSD (90%)	PSD-P (90%)	*Wr*≥S (90%)
2007	58	58.0 (22.4)	58.0 (22.4)	98 (3)	52 (11)	105.7 (1.0)
2009	13	13.2 (8.8)	12.2 (9.0)	92 (15)	42 (27)	96.4 (2.9)
2010	6	6.1 (3.2)	6.1 (3.2)	33 (43)	0	99.6 (8.6)
2011	6	6.0 (5.6)	6.0 (5.6)	83 (33)	67 (45)	104.4 (41.5)
2012	28	28.0 (18.0)	20.0 (11.6)	70 (18)	30 (18)	97.6 (4.5)
2013	2	4.0 (3.8)	4.0 (3.8)	100	50 (50)	64.4 (142.90)

Black Crappie

Black Crappie is a highly targeted species in Stockade Lake. During an angler use survey in 2011 they were the most frequently caught species during May-July. Trap nets are used annually to monitor this popular game fish and the management goal is to maintain CPUE-S greater than 10, PSD greater than 20 and PSD-P greater than 5.

Trap net abundance (CPUE) has been low in recent years' surveys and was less than one during 2013 (Table 9). Only five Black Crappies were collected in trap nets and 22 in gill nets during the 2013 survey (Tables 1 and 2). With so few individuals caught, size structure and condition analysis are difficult.

The management goal for CPUE has not been reached with trap net surveys within the last few years. Prior to 2011, trap nets were set in September and is an important factor to consider when comparing samples from previous years. Possible reasons for the recent low catch rates in trap nets are timing of the survey or placement of nets. Other options to sample this population will be explored in the future to make sure the samples properly represent the population.

Table 9. Results for Black Crappie collected in trap nets during surveys of Stockade Lake, 2007-2013. Parameters are reported with confidence intervals.

Species	N	CPUE (80%)	CPUE-S (80%)	PSD (90%)	PSD-P (90%)	*Wr*≥S (90%)
9/2007	93	11.6 (8.7)	11.6 (8.7)	1 (2)	1 (2)	97.5 (0.6)
9/2008	29	3.6 (1.6)	2.3 (0.9)	11 (13)	0	99.4 (--)
9/2009	77	9.6 (3.5)	8.8 (3.4)	39 (10)	0	101.3 (0.3)
9/2010	65	8.1 (2.6)	8.1 (2.6)	46 (10)	0	100.2 (1.6)
6/2011	7	0.8 (0.7)	0.8 (0.7)	100	0	90.8 (0.6)
5/2012	13	1.6 (1.1)	1.5 (1.1)	75 (23)	0	102.8 (2.3)
5/2013	5	0.63 (0.35)	0.38 (0.25)	40 (52)	67 (33)	103.7 (21.9)

Northern Pike

Northern Pike are an angler targeted species in Stockade Lake. Catch rates of Northern Pike have been low in surveys the last few years (Tables 10 and 11). A majority of the fish captured were over preferred length in 2013. Population analysis is difficult with low catch rates, but condition (*Wr*) for Northern Pike has been excellent for several years with values close to and over 100. With the high number of prey fish available in Stockade, Northern Pike should continue to have good growth and condition.

Table 10. Results for Northern Pike captured in gill net surveys in Stockade Lake, 2008-2013. Parameters are reported with confidence intervals.

Species	N	CPUE (80%)	CPUE-S (80%)	PSD (90%)	PSD-P (90%)	*Wr*≥S (90%)
2008	14	7.0 (9.2)	7.0 (9.2)	100	7 (13)	98.0 (3.1)
2009	14	7.0 (6.2)	7.0 (6.2)	93 (13)	0	96.1 (2.4)
2010	1	0.5 (1.5)	0.5 (1.5)	100	100	104.3
2011	5	2.5 (1.5)	2.5 (1.5)	100	100	95.7 (5.7)
2012	1	0.5 (1.5)	0.5 (1.5)	100	0	98.0
2013	2	1.0 (3.1)	1.0 (3.1)	100	100	88.1 (0)

Table 11. Results for Northern Pike captured in trap nets in Stockade Lake, 2008-2013. Parameters are reported with confidence intervals.

Species	N	CPUE (80%)	CPUE-S (80%)	PSD (90%)	PSD-P (90%)	*Wr*≥S (90%)
2008	4	0.5 (0.4)	0.5 (0.4)	0	0	n/a
2009	8	1.0 (0.5)	1.0 (0.5)	88 (24)	13 (23)	91.0 (5.1)
2010	5	0.6 (0.4)	0.6 (0.4)	60 (52)	40 (52)	102.6
2011	8	0.9 (0.3)	1.0 (0.3)	100	43 (39)	95.1 (4.9)
2012	2	0.2 (0.2)	0.2 (0.2)	50 (50)	50 (50)	96.5
2013	7	0.88 (0.6)	0.88 (0.6)	71 (29)	57 (39)	98.1 (4.3)

Bluegill

Bluegill is a new species that showed up in 2007. Prior to the 2011 survey, this species appeared to be increasing and made up 66% of the total catch in 2010 with 467 caught. Abundance (CPUE) was low again this year with a value of 4.6 (Table 12). Like Black Crappie, this is likely due to timing of the survey or placement of nets. Length frequencies from 2008-2010 show the 2007 year class, and change in sizes of those two year classes over a 3 year period (Figure 4). Year classes were not distinguishable in 2011-2013. Few fish were surveyed in 2013, and a majority of the fish were quality length (>150 mm or 6 in). The PSD-P increased to 19 (Figure 3). Fish condition remains excellent with an average *Wr* for stock length and larger fish of 121.

Bluegills were the second most caught fish during the 2011 creel with an estimate of over 7,000 caught (Simpson 2011). This is about the same as Yellow Perch catch and roughly half of the Black Crappie catch. Also it was interesting that Bluegill, despite being the third most harvested species, was not noted as being a species anglers were targeting. It will be interesting to watch how this population affects other species, such as Largemouth Bass and Black Crappie.

Table 12. Results for Bluegill collected in trap nets during surveys of Stockade Lake, 2007-2013. Parameters are reported with confidence intervals.

Species	N	CPUE (80%)	CPUE-S (80%)	PSD (90%)	PSD-P (90%)	*Wr*≥S (90%)
2007	26	3.3 (3.1)	3.3 (3.1)	81 (14)	0	96.2 (2.7)
2008	36	4.5 (1.6)	4.5 (1.6)	11 (9)	8 (8)	117.9 (4.5)
2009	126	15.8 (12.2)	15.8 (12.2)	28 (7)	3 (3)	112.4 (1.1)
2010	467	58.4 (37.8)	58.4 (37.8)	93 (3)	2 (1)	114.8 (2.8)
2011	22	2.7 (1.8)	2.7 (1.8)	55 (19)	5 (7)	107.7 (3.5)
2012	25	3.1 (2.1)	3.1 (2.1)	80 (14)	16 (13)	128.6 (4.2)
2013	37	4.6 (3.2)	4.6 (0.35)	86 (10)	19 (11)	120.7 (6.5)

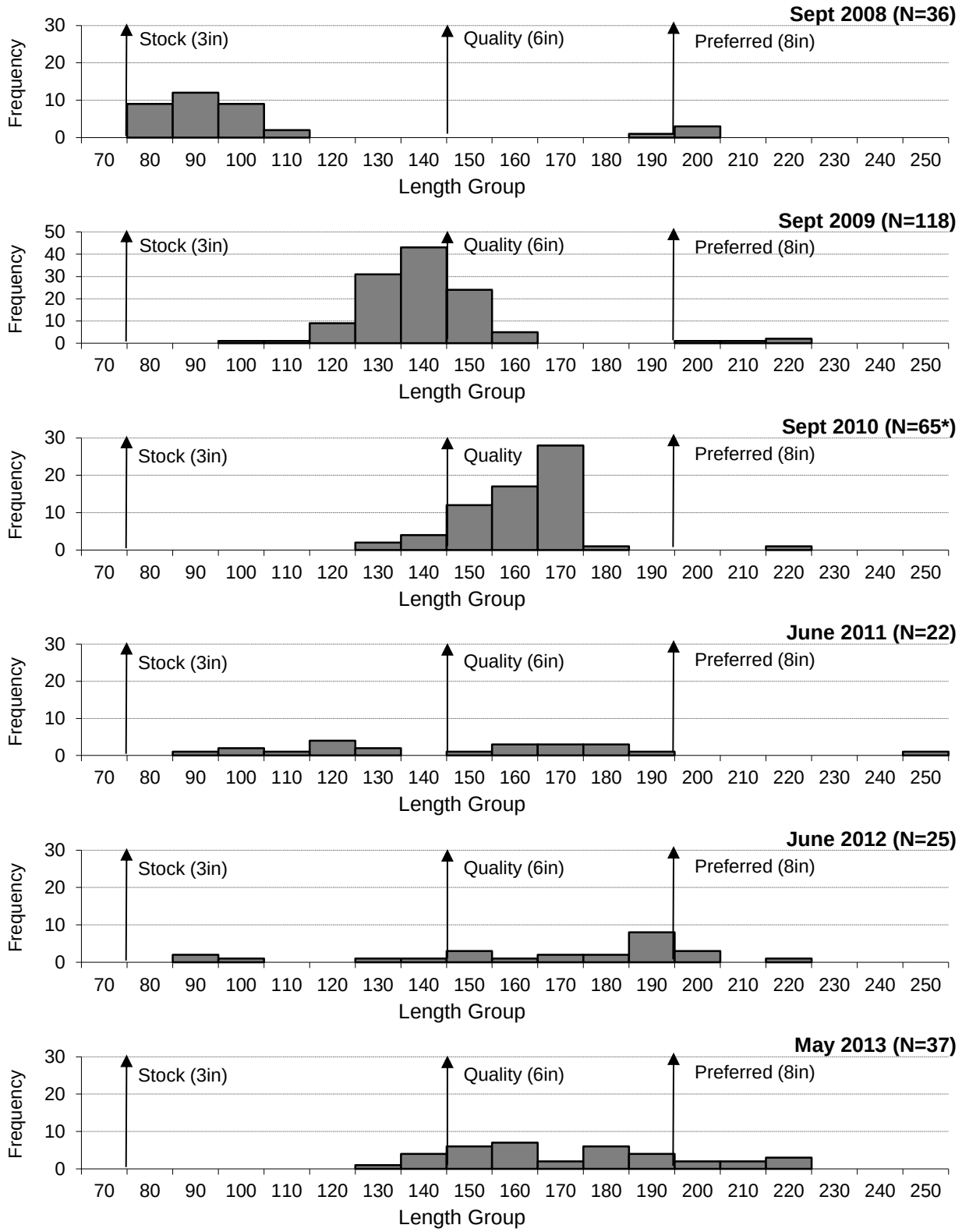

Figure 4. Length frequency histograms for Bluegill collected during trap net surveys of Stockade Lake in 2007-2012. *only measured fish are included in 2010. Note larger frequency range in 2009.

Rainbow Trout

Rainbow Trout stockings were discontinued after 2009. Summer temperatures and oxygen stratification limit the available habitat for trout.

RECOMMENDATIONS

1. Resurvey in 2014 to monitor all fish populations.

2. Collect scales from Largemouth and Smallmouth Bass to further evaluate growth trends.

REFERENCES

Simpson, Greg. 2011. Angler Use and Harvest Survey on Stockade Lake, South Dakota, May - July, 2011. South Dakota Department of Game, Fish, and Parks. F-21-R-43

Willis, D.W., D.A. Isermann, M.J. Hubers, B.A. Johnson, W.H. Miller, T.R. St. Sauver, J.S. Sorensen, and E.G. Unkenholz. 2001. Growth of South Dakota fishes: a statewide summary with means by region and water type. Special Report. South Dakota Game, Fish, and Parks. Pierre, South Dakota.

APPENDIX

Appendix 1. Stocking record for Stockade Lake, South Dakota, 1999-2013

Year	Species	Size	Number
1999	Rainbow Trout	Fingerling	77,580
2000	Rainbow Trout	Adult	10
2001	Rainbow Trout	Fingerling	69,844
2002	Rainbow Trout	Fingerling	30,000
	Rainbow Trout	Catchable	1,194
	Rainbow Trout	Adult	20
2003	Largemouth Bass	Adult	409
	Rainbow Trout	Adult	50
2004	Brown Trout	Catchable	3,250
2005	Brown Trout	Catchable	3,250
2006-2008	None stocked		
2009	Rainbow Trout	Fingerling	1,500
2010-2013	None stocked		